

Repair of Tendons in the Hand

JAMES N. WILSON, M.D., Los Angeles

SUCCESSFUL SURGICAL REPAIR of tendons depends in large part on understanding the physiological processes by which tendons heal and on correlating this knowledge with the specific problem of repair that the surgeon faces at the operating table.

In the hand, tendons are found in two different anatomical environments. In the fingers and thumb the flexor tendons glide within synovial sheaths. The blood supply to them is precarious and is carried through a mesotenon similar to the mesentery of the intestine. When a tendon is cut within the sheath, muscular pull draws the ends apart. Since there is little supply of blood to the tendon and contiguous sheath, very little inflammatory fibroplastic reaction occurs. At operation the ends of the tendon are found to be smooth and rounded off and not adherent to the surrounding tissue. Frequently extravascular unclotted blood is observed within the sheath.

In the remainder of the hand and in the forearm the situation is considerably different. There the tendons lie within loose, filmy areolar tissue called paratenon. The blood supply there is abundant and comes from many different directions. When a tendon is cut within paratenon, nature attempts to bridge the gap by proliferation at the cut ends. The tendon fibrils rapidly grow out like pseudopodia and fuse with the nearest surrounding tissue. When such a tendon is repaired, accurate end-to-end apposition of the cut surfaces must be achieved. Overlapping ends will result, as Bunnell¹ put it, in "unsatisfied" tendon fibers. The unsatisfied ends will adhere to the surrounding tissue and thus act as a check-rein to the gliding motion of the tendon.

Frequently raised is the apparently rational conjecture, "Inasmuch as a tendon is a gliding structure, shouldn't motion be started soon after injury to keep the tendon from becoming adherent?" This at first sounds reasonable. However, nature has provided a solution for this problem, as has been found in studying the process of tendon repair.

Immediately following repair of a tendon, the strength at the juncture is only as great as the knot that holds the two ends together. During the following several days the union becomes weaker due to the hyperemia and softening that occur. In the first

• The physiologic processes by which tendons of the hand heal after injury differ from one part of the hand to another.

Although definitive operation immediately after injury is advisable in many cases to avoid infection, factors other than infection may be more important and dictate delay.

While early exercise to mobilize the tendon soon after repair would seem logical, actually the process of healing is such that during the third week the tendon is spontaneously freed from adherence to surrounding tissue. Motion earlier than that causes irritation at the point of suture of the two ends of the tendon and increases scar. After completion of the healing process, motion serves to increase the strength of the new tendon fibrils.

week the ends of the tendon are joined by soft clot containing fibroblasts and capillaries and there is no bridging of the gap by new tendon fibers. In the second week the tendon fibers proliferate and become interlaced within the fibers of the opposite side, but the juncture is without material strength. During this period the tendon is stuck in a mass of soft tendon callus which incorporates not only the tendon but the surrounding structures which contribute to the healing process. During the third week a process of selective absorption of the surrounding scar occurs in such a way as to free the tendon from the tissue to which it was previously adherent.

It is at this period, between the fifteenth and twenty-first days, when nature is carrying out tenolysis, that active but protected motion should be started. It has been shown experimentally that if motion is started before this period, the suture line becomes boggy and edematous in response to the mechanical irritation. Following this period, active motion provides a stimulus to the increasing strength of the new tendon fibrils.

DETERMINING FACTORS IN PRIMARY REPAIR

Since infection is probably the complication that most often interferes with attaining good results in tendon repair, the time factor is extremely important. The so-called "golden period" of six to eight hours between the time of injury and repair has

Presented before the Section on Industrial Medicine and Surgery at the 82nd Annual Session of the California Medical Association, Los Angeles, May 24-28, 1953.

probably been appreciably extended by the new antibacterial drugs. The degree of contamination of the wound may cause the surgeon to shorten or extend the time period, the decision depending upon the probability for the development of infection in the particular case in question. Other factors come into play along with the time element, however. The amount of accompanying trauma to tissue exclusive of the damage to the tendon has been shown to have a direct bearing on the end results. Extensive trauma necessitates prolonged immobilization, causes increased edema and excessive formation of scar tissue. Frequently nerves are damaged. This results in trophic disturbances with consequent impairment of tissue nutrition and delay in healing. Definitive repair of a tendon should not be carried out if fractures of any great magnitude are associated with the damage to the tendon. The fracture requires immobilization for eight to ten weeks. A damaged tendon kept immobile for so long a time would become firmly adherent in cicatrix.

Operation should be done only in a hospital and preferably with the patient under general anesthesia. In any procedure on the hand, the operative field should be kept bloodless. This can be done by the use of a pneumatic tourniquet. A simple blood pressure cuff inflated to 300 millimeters of mercury is adequate for the purpose. The extremity may thus be rendered ischemic for one and one-half hours without ill effect. The lighting and stability of the operative field should be such that the surgeon can perform the frequently meticulous technique that is requisite to achieve good end results.

Primary repairs in certain areas in the hand have always been associated with poor results. Even with the great advances that have recently taken place in surgery of the hand, there seems to be as yet no solution to the problem of primary repair of flexor tendons between the central crease of the palm and the middle flexion crease of the fingers. In event of

damage to tendons there, only closure of the wound should be carried out at first and all efforts made to secure wound healing at the earliest possible time. A tendon graft of the profundus tendon only from the tip of the finger to the palm can then be undertaken as a secondary reconstructive procedure.

TECHNIQUE OF REPAIR

A leading orthopedist recently said that the best way to secure fixation of fractures is "to wish the ends together and hold them by moral suasion until healing takes place." The same may be said of tendons. The ideal suture is one that could be inserted without trauma, would attain perfect apposition of the ends of the tendon, would cause no foreign body reaction, and could be left in place indefinitely. Bunnell's techniques with the use of stainless steel wire would seem to come closest to the ideal.

The kind of suture varies with the location of the injury. On the flexor surface, strength of repair is important and the interwoven stitch is commonly used. It is important not to bury wire in tactile areas, such as those in the fingers, for if there is not enough overlying soft tissue the wire knot causes pain and tenderness. In deeper areas like the palm and wrist, wire may be buried with impunity. On the extensor surface, tension suture is less important and coaptation of the ends of the tendon with removable figure-of-eight suture is usually sufficient. The tension at the suture line is overcome by positioning of the adjacent joints, which are immobilized by plaster until healing takes place.

For a more complete description of the technique and rationale of tendon suture, the reader is referred to Bunnell's excellent book.

1401 South Hope Street.

REFERENCE

Bunnell, Sterling: *Surgery of the Hand*, 2nd edition, J. B. Lippincott, Philadelphia, 1948.